DOCUMENT RESUME

ED 319 596 SE 051 406

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TITLE Affecting Preservice Elementary Teachers' Attitudes toward Inquiry Teaching in Science through Projects with Individual Children.
PUB DATE 90
NOTE 11p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (63rd, Atlanta, GA, April 8-11, 1990).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Science; *Elementary School Teachers; Higher Education; Inquiry; *Methods Courses; *Preservice Teacher Education; *Science Instruction; *Science Teachers; *Teacher Attitudes; Teacher Education Curriculum; Teacher Education Programs

ABSTRACT

The purpose of this study is to improve attitudes toward learning science and inquiry-based, science teaching through specially designed instruction in a science methods course for preservice teachers. Eighty preservice teachers over two terms elected to complete one of two projects as part of their science methods course. The "Discussions in Science" (DiS) project used a science topic as the basis for discussions between teacher and child. The teachers analyzed children's thinking about sciences as well as variables affecting inquiry science teaching. The "Mentorship Program" (MP) project used a topic jointly selected by a middle school able learner and the teacher based on a mutual interest. These topics were generally in the social sciences and the project focused on developing a presentation by the able learner. The Test of Science-Related Attitudes and Preferences and Understandings were adapted to measure attitudes toward science and inquiry teaching. Paired t-tests of pretest and posttest gain scores showed a significant increase in attitudes toward inquiry teaching in the DiS project and not in the MP project. An analysis of covariance holding pretest attitudes constant failed to show a significant difference. (Author/YP)

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Affecting Preservice Elementary Teachers' Attitudes Toward Inquiry Teaching in Science through Projects with Individual Children

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Abstract

Preservice elementary teachers have positive attitudes toward and knowledge of science process skills. They score as well as preservice secondary teachers on tests of knowledge about process skills (Lawrenz & Cohen, 1985). These results contrast sharply with the well documented dearth of science instruction in the elementary grades. The purpose of this study was to improve attitudes toward learning science and inquiry-based, science teaching through specially designed instruction in a science methods course for preservice teachers (Sunal, 1982).

Eighty preservice teachers over two terms elected to complete one of two projects as part of their science methods course. The projects were considered different treatments for the purpose of this study. Each treatment involved conducting an in-depth, inquiry-oriented project with one child for the duration of the course. The DiS project used a science topic as the basis for discussions between teacher and child. The teachers analyzed children's thinking about science as well as variables affecting inquiry science teaching. The MP project used a topic jointly selected by a middle school "able learner" and the teacher based on a mutual interest. These topics were generally in the social sciences and the project focused on developing a presentation by the "able learner".

The Test of Science-Related Attitudes (Fraser, 1978) and Preferences and Understandings (Kyle, Bonnstetter, & Gadsden, 1988) were adapted to measure attitudes toward science and inquiry teaching. Paired t-tests of pretest and posttest gain scores showed a significant increase in attitudes toward inquiry teaching in the DiS project and not in the MP project. An analysis of covariance holding pretest attitudes constant failed to show a significant difference.

The result that the DiS activity competed on equal terms with a project-centered activity mainly in the social sciences is examined in light of preservice teachers perceptions of the purpose science education. Other data from the study suggesting relationships between attitudes and age, sex, and science knowledge are considered in a discussion about future research.

The Problem

Preservice elementary teachers have positive attitudes toward and knowledge of science process skills. They score as well as preservice secondary teachers on tests of knowledge about process skills (Lawrenz & Cohen, 1985). These results contrast sharply with the well documented dearth of science instruction in the elementary grades. Prospective elementary teachers have a mind set beneficial for science instruction but lack the confidence in their current science knowledge necessary to motivate the learning of more science knowledge to support a long-term commitment to science education. The purpose of this study was to improve attitudes toward learning science and inquiry-based, science teaching through specially designed instruction in a science methods course for preservice teachers (Sunal, 1982).

Toward a Solution

My experience with preservice teachers suggests that, while they recognize the importance of teaching science, their enthusiasm for a concept and process-based approach to science instruction often wanes as they get into the daily responsibilities of a teaching job. This suggests that Lawrenz and Cohen's (1985) results show an abstract understanding of what science is all about, but that teachers can see little relationship to their job of classroom teaching.

I have had success with an approach to teaching about inquiry methods where preservice teachers conduct "Discussions in Science" while doing activities with a single child (Flick, 1989). The Discussions are Piagetian-type interviews designed and practiced during science methods coursework. The term "discussion" is used because the term "interview" seems to suggest a survey-type discussion. Discussing science connotes a closer and more equal relationship between the preservice teacher and the child around a topic of mutual interest. Qualitative evaluations showed that this intimate involvement with the thinking of a single child had positive effects on the preservice teacher's attitudes towards engaging children in science activities as well as their understanding of the issues associated with inquiry teaching. These issues include wait-time, the importance of manipulative activity, and the function of process skills in science instruction. They also express feeling better about their own ability to learn and use science knowledge.

The science methods course is integrated with social studies methods. One means of integration is through participation in a Mentorship Program coordinated by the Talented and Gifted Institute at the University of Oregon. The program is similar to Discussions in

Science (DiS) in that preservice teachers work with only one middle school student in facilitating inquiry into a topic jointly chosen by the student "protege" and the preservice "mentor". The inquiry focus and "one-on-one" design suggested that on the surface the Mentorship Program (MP) made a comparable alternative to the Discussion project.

However, on closer examination there were important contrasts. The DiS projects had a specific science focus whereas the MP projects generally had a social science flavor. The most interesting difference, however, was in the focus of activity. The Mentors focused on the idiosyncratic topic whose choice was heavily influenced by the personal interests of the middle school student "protege". Most of the proteges were identified by the school district as "able learners". This reinforce the subject matter focus for the preservice teachers working in the program.

The DiS project used a specific area of physical science content to focus the activities and verbal interactions with elementary age children. Both projects motivated preservice teachers through a personal involvement with children, but the DiS project specifically structured reflection on children's thinking by analyzing tape recordings of discussion sessions and pooling information on children's ideas. Embedded in this reflective activity was a double douse of inquiry: (a) inquiring into the science concepts and (b) inquiring into the child's ideas.

With these differences in mind, I considered the two projects different treatments. For two terms, students either selected the MP or DiS program as part of their science methods course. Instruction time associated with each program was equal. MP instruction was conducted by the school district coordinator for middle school talented and gifted programs and a graduate student liaison. The DiS instruction was conducted by myself and a graduate student. Weekly meetings served to coordinate the two programs within the course and validate difference in treatment.

Subjects

Because of the commitment of time away from campus, students had to volunteer for the Mentor Program precluding random assignment. The two groups were highly similar on important demographic and academic variables. The groups were comparable in size: DiS=44 and MP=36. Chi-squared tests (df=1, N=80. $P < .05$) showed no between group differences by sex ($X^2 = 1.014$), age ($X^2 = 3.490$), academic background in science ($X^2 = 2.434$), or knowledge of science ($X^2 = 1.923$). Both groups were over 80% female.

Instrumentation

The Test of Science-Related Attitudes (Fraser, 1978) was used as the basis of an instrument for comparing the two groups. While the TOSRA was written for high school students, only a few minor changes were necessary to adapt the statements for teachers. For instance, in a statement from the Attitude Toward Scientific Inquiry subscale, "Doing experiments is not as good as finding out information from teachers" the word "teachers" was changed to "experts". This study used two of the eight subscales contained in the TOSRA: Attitude toward Scientific Inquiry and Adoption of Scientific Attitudes. The Scientific-Inquiry subscale contains statements about experimenting and sharing results to learn more about the world, whereas the Adopting-Scientific-Attitudes subscale contains statements about curiosity, challenging ideas of experts, and suspended judgement.

Attitudes toward inquiry teaching was measured with items contained in Preferences and Understanding: Teacher Version (Kyle, Bonnstetter, & Gadsden, 1988; Yager & Bonnstetter, 1984). The knowledge items from this questionnaire were used as a measure of general science knowledge. The Inquiry-Teaching items were written in the form of statements to conform to the five-level Likert-type items of the TOSRA. Scoring for positively stated items ranged from 5 Strongly Agree to 1 for Strongly Disagree. Negatively stated items ranged from 5 for Strongly Disagree to 1 for Strongly Agree. Each attitude scale was scored on the basis of 50 points for the most positive attitude.

Data and Analysis

The attitude survey was given at the beginning and at the end of the term for two classes during the 1988-89 academic year. Paired T-tests of the pretest to posttest gains in Inquiry Teaching was significant for DiS but not for MP (see Table 1). An analysis of covariance of the posttest Inquiry Teaching scores blocking on age, sex, and treatment, however, showed no significant treatment effect, $F(9, 70) = 1.27$, $p < .27$. The covariates were the pretest scores on Scientific Inquiry, Adopting Scientific Attitudes, and Inquiry Teaching. Pretest Inquiry Teaching scores were the best predictor of posttest Inquiry Teaching scores.

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insert Table 1 about here

Inspection of the means collapsing both groups into one suggested some interesting qualitative relationships. As pretest science knowledge increased so did the pretest scores on Inquiry Teaching and the greater the posttest gain. More science knowledge would

result in seeing more inquiry teaching opportunities. Females (N=68) showed an increase of 3.1 points in Scientific Inquiry where males (N=12) showed none. Two age groups were compared, college seniors (20-24 years, N=31) and older returning students (25-54 years, N=49). Both groups showed an increase in Scientific Inquiry with the college seniors showing a somewhat larger increase.

Discussion

The treatments did not appear to be that different. The students came in with generally positive attitudes toward a scientific frame of mind and inquiry teaching and left with those attitudes slightly improved. The use of a specific science topic and emphasis on children's thinking in the DiS program did not contrast sharply with the science/social studies focus and subject-matter emphasis of the MP program.

There was general apprehension by the preservice teachers in both programs over the subject-matter content that they were to use as a basis for their projects. The DiS group had a shared topic, the nature of matter, where the MP group chose their topics on the basis of a mutual interest with a middle school student. Each group had the need to find outside resources to improve their understanding of the topic in order to adequately prepare for their one-on-one meetings. Therefore, personal inquiry into specific subject matter was approached in a similar way. This has positive implications for programs such as Science, Technology, and Society whose goal it is to show relationships between science and social issues. Apparently positive attitudes toward inquiry teaching can be maintained and improved through topics in both the natural and social sciences. In fact, it may be inappropriate to assume, especially at the elementary level, that there is any perceived difference between these disciplines when students are actively involved in inquiry-oriented instruction.

The result of "no significant differences" may be viewed as a vote in favor of using the DiS approach for promoting inquiry teaching in elementary and middle school science. If science instruction, especially inquiry, activity-based instruction, is systematically avoided at the elementary level, then one might expect that the DiS group would come out on the short end of the stick. This was clearly not the case.

Preservice elementary teachers perceive the purpose of science education as primarily "Teaching science information" (58%) followed by "Awareness of the world" (38%). "Problem solving" (23%) and "Science processes" (10%) are considered much less important (Zeitler, 1984). The DiS activity distinctly promotes the latter two purposes while maintaining an emphasis on the importance of understanding specific science

information. The overwhelming concerns of the preservice teachers about teaching science in Zeitler's (1984) study were "Science content knowledge" and "Classroom management". Working with only one child is not the same as leading inquiry instruction with a whole a classroom. However, working with individual children does bring the preservice teachers "face to face" with their skill in presenting and discussing science knowledge. This was not easy for many of them, yet their final reports and transcripts of "discussions" indicated many rewarding events. The result that the DiS activity competed favorably with a project-centered activity mainly in the social sciences is significant even if not in the statistical sense.

Further Research

At least three aspects of the project warrant further investigation. The DiS group were required to tape record and transcribe portions of their sessions. A complete description of this approach has been given elsewhere (Flick, 1989). These tapes were used to demonstrate the meaning of wait-time. Rough estimates of wait-time behavior were made as well as the frequency, duration, and cognitive level of the child's responses. This format for directly experiencing wait-time may have effects in student teaching and beyond. Follow-up studies are needed to trace the effect on wait-time in the classroom as well as determine what types of supervision and practicum settings would reinforce the skills of elementary teachers for conducting inquiry science.

The concern of preservice teachers about their science content knowledge may derive in part from the perceived purpose of science education as transmitting that knowledge. This anxiety about inadequate knowledge inhibits the use of their considerable knowledge of science processes (Lawrenz & Cohen, 1985) and their positive attitudes toward scientific inquiry shown in the current study. It would be interesting to know what topics are used by beginning or student teachers for conducting inquiry lessons and what knowledge they gained in preparing for that instruction. In addition, studies should inquire into how they felt about their experiences and what relationship they saw between inquiry-oriented science instruction and other parts of the elementary curriculum.

Ginns & Foster (1983) report that a "topics approach" in college science classes favored females, whereas males were favored by a "lecture approach". The topics approach included units of work around library research, written reports, and hands-on activities. The lecture approach involved a structured classroom and lab environment. In the current study, attitudes toward scientific inquiry increase by a little over three points for

females with no increase for males. This difference suggests that the effects of the DiS program may be mediated by gender differences.

Hurd (1986) has said that the crisis in science education arises from the disjuncture between modern science and the existing character of science in the classroom. He advocates less in the way of immediate, ad hoc solutions initiated by legislation and more informed and reflective thought about scientific knowledge, personal values, and the purposes of education. New teachers are particularly vulnerable to external authority and may remain under that influence for many years before beginning to think reflectively about their job. The Discussions in Science project is one way of focusing on scientific knowledge, personal values, and the purposes of education without being caught up in the machinery of classroom teaching. Perhaps future research and innovative program design can find ways to bring together an integrated program of teacher preparation, practicum supervision, and inservice programs to sustain a process of informed, reflective thought about the purposes of education in science.

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Table 1

Paired Comparison T-Tests by Treatment Group for Attitude Gain Scores

Attitude Scale	Mean Gain Score	Std. Error	T
DiS group			
Scientific Inquiry	2.818	.0837	3.37*
Scientific Attitudes	1.205	.512	2.35*
Inquiry Teaching	1.237	.632	2.01*
MP group			
Scientific Inquiry	2.417	.780	3.10*
Scientific Attitudes	.889	.627	1.42
Inquiry Teaching	.917	.643	1.43

*$p < .05$